REMARKS/ARGUMENTS

Reconsideration of this application is requested. Claims 31-35, 37-39, 41-54 and 56-62 will be pending in the application. Of these claims 32, 34, 35, 44 and 46-50 have been withdrawn from consideration as directed to non-elected subject matter.

In the current Official Action all previous rejections have been withdrawn and newly identified prior art has been cited and applied to the claims now pending. There is a single prior art-based rejection, one of alleged obviousness over the two newly cited documents: the new rejection is based on GB 2362164 (Godfrey) in view of US 2,876,094 (Lusby).

In order to advance examination the claims have been amended in order to more particularly point out and distinctly claim that which applicants regard as their invention and to direct them to preferred aspects of disclosure. More specifically, claim 31 is amended, claim 55 canceled (as effectively incorporated into claim 31) and new claim 62 added. Basis for the amendments to claim 31 and new claim 62 will be apparent from the discussions that follow.

Turning now to the two newly cited references, Godfrey teaches a method for producing Ti and Ti alloy <u>powders</u> by electrolytic reduction, using a bimodal particle-size feedstock (page 1, lines 13 to 15). After electrolytic reduction of this feedstock, the result is "a friable block which can easily be broken up into powder" (page 1, lines 22 to 23). Further detail is given at page 3, lines 3 to 4 and lines 8 to 10.

The present application describes a method for the purification of metal particles, and in particular particles which have been produced by electrochemical reduction, for example as described in GB 2362164.

The method described in the present application involves, as defined in claim 31, introducing the metal particles (manufactured by an electrochemical reduction process) into a heat source, and melting and re-solidifying the particles.

Lusby describes a method for purifying refractory metals, such as titanium, following production of the metals by reduction of the metal halide. A pressed rod of refractory metal in the form of sponge is passed downwards into a heating zone, wherein the rod is progressively heated and melted (column 1, lines 59 to 62). The rod melts, and molten droplets of the metal fall from the end of the rod (column 1, lines 68 to 72) and optionally re-solidify as they fall (column 2, lines 10 and 11).

The most fundamental difference between Lusby and the present invention is therefore that Lusby forms droplets by melting metal sponge within a heating zone, while in the present invention, the metal particles are introduced individually into a heat source, and are heated, melted, and re-solidified individually, without contact with each other or with a container. Claim 31 has been amended to clarify this point, using language from page 5, lines 6 to 9 of the application.

In the present invention, metal <u>particles</u> are made by electrolytic reduction. This is clearly stated in the introduction to the present application and examples of methods for making powder or particles by electrolytic reduction are given from page 1, line 21 to page 3, line 2. Other methods, such as the method described in GB 2362164, may also be used. The important factor is that the feedstock for the claimed purification method is a volume of individual, separate metal particles, which can be fed, for example, using a hopper (e.g. page 13, lines 5, 15 and 28; from which powder or particles can be poured, see page 13, line 30). The use of separate particles is also clearly shown in the drawings.

As described in the subject application, particles formed by electrolytic reduction may contain various contaminating impurities (page 3, lines 4 to 12) and may be irregular in shape (page 4, lines 17 to 23). The method of the invention advantageously heats, melts and re-solidifies each particle individually, in order to remove impurities and to spheroidize and densify each individual particle. Thus, the properties of the particles are significantly improved for subsequent powder processing applications, and the size of the particles is not increased. In fact, the process of spheroidizing and densifying each individual particle means that the particle size (diameter) will generally be <u>decreased</u> by the method.

Thus, the method of the invention provides a purified powder with a fully dense spherical particle morphology, as is desirable for powder processing. Increasing the particle size would be highly undesirable. Powder metallurgy processes such as sintering or forging (page 3, lines 14 to 17) are advantageously performed using small particle sizes.

By contrast, in Lusby's process, the particle size of the purified metal product is determined by the size of the molten droplets of metal, which are melted from the heated rod of metal sponge. Lusby gives no specific indication of particle sizes, but it seems highly unlikely that melting sponge and allowing molten droplets to fall from it can allow the formation of very

small particles. The Examiner points, at page 5 line 12 of the Office Action, to column 3 lines 25 to 28 of Lusby, which state that variations of certain parameters can allow the skilled person to obtain "the desired purity and surface area" of the product particles. Lusby refers to "the particle size" as a parameter which may be varied, but it is not clear whether this refers to the particles obtained by re-solidification of molten droplets of metal (column 2, line 15) or the particles from which the pressed rod is formed (column 2, line 43). In any event, however, the size of the molten droplets will not be the same as the size of the particles within the pressed rod. As is clearly shown in Lusby's Figure 1, the tip of the pressed rod is simply melted to a point, and liquid droplets fall from the point.

At page 5, lines 12 to 16, the Examiner states that Lusby teaches adjustment of the particle size. In the present invention, the particle size cannot be adjusted. The size of the purified metal particles is directly determined by and corresponds to the particle size of the powder or particles before purification. Each particle is individually purified, densified and spheroidized.

The reference in Lusby to "the pressed rod 8 of titanium particles" at column 2, lines 42 to 43, seems odd. The rod is made of pressed sponge (column 1, lines 59 to 61) and not particles. In any event, once the rod has been melted, any identifiable 'particles' in the pressed rod can no longer be identifiable. They cannot correspond to the purified 'particles' produced by Lusby's method.

Various points in Lusby indicate that his method produces particles which are much larger than the particles described in the present application.

Claim 51 of the present application states that the cooled metal particles are up to about 1 mm in diameter. A 1 mm diameter particle of titanium has a mass of approximately 2.4 mg. Column 2, lines 42 to 47 of Lusby state that a pressed rod of titanium particles of 4 inch diameter and 85% density can be processed at 3 inches per minute. This corresponds to 2.4 kg of metal per minute. To produce droplets of 1 mm diameter, Lusby's method would therefore need to produce 1,000,000 droplets each minute. It seems improbable that molten droplets could form and fall at this high rate from the pointed end of the molten rod, as shown in Figure 1. This corresponds to almost 17,000 droplets per second. At column 2, line 58, Lusby claims that his

method can process metal at 5 lbs of titanium per minute. This would require an even faster rate of droplet formation.

In practice, it is completely clear that Lusby cannot be producing droplets of 1 mm diameter. His droplets must be very much larger than this.

It is notable that Lusby does not describe his purified particles as being suitable for powder processing. Column 2, lines 56 to 57, state that the metal particles are suitable for melting and casting. This is entirely consistent with a particle size much larger than 1 mm.

Another key difference from Lusby is that in the present application, the metal particles manufactured by an electrochemical reduction process are introduced into a heat source, such that the particles are out of contact with any surfaces and out of contact with each other. In Lusby, if the pressed rod can be considered to be fabricated from particles at all, these particles are only introduced into the heat source in contact with each other, such that metal droplets form by melting. There is no one-to-one relationship between the "particles" within the pressed rod and the molten droplets. The particles in Lusby must be read as the molten droplets themselves. These are not "introduced into a heat source". They are formed within a heat source and fall out of the heat source. By contrast, in the present application, individual particles are introduced separately into a heat source.

Page 4, lines 2 to 5 of the Office Action state that it would have been obvious to have used the method of Lusby to have purified the particles of Godfrey, because Lusby teaches that his method avoids contamination of the metal. This is not correct, because Godfrey teaches a method for making Ti powder. The powder is described as being passed through a 250 μm sieve. The particle size of the powder is therefore very much smaller than the purified particles produced by Lusby. To use Lusby, the skilled person would have to press Godfrey's particles into a 4 inch rod and progressively melt the rod. Since the skilled person used Godfrey in the first place to make fine particles, pressing the particles into a rod would be highly undesirable. The skilled person reading Godfrey and wishing to purify Godfrey's particles would have looked for method for purifying the powder without increasing the particle size, so that it could still pass through a 250 μm sieve, for example. As described in Godfrey, Ti and Ti powders of this type are of tremendous economic importance, and increasing the particle size of the powders would be highly undesirable (page 1, line 5). By contrast to Lusby, the present invention allows

purification, spheroidization and densification of the individual particles produced by Godfrey, for example, without any increase in particle size, which would inevitably result from the method of Lusby.

For the above reasons it is respectfully submitted that the claims of this application define inventive subject matter. Reconsideration and allowance are solicited. Should the examiner require further information, please contact the undersigned.

Respectfully submitted,

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